The 21st century has been full of technological advancements—touch-screen phones, holographic performances, space tourism, 3D and DVD technology, and so much more. What a wonderful time to be alive! Living in a world of so many accomplishments, it is easy to forget how microscopic we really are. The earth is diminutive in perspective; the edge of our galaxy is 75,000 light years away, the next closest galaxy is 2.5 million light years away, and there are estimated to be 200 billion galaxies in the universe. The earth is a small puzzle-piece in the many billions of fragments that make up the universe. The universe is full of stars and planets, eclipses and supernovas—happenings we can only begin to understand, even in this superior technological era. I am interested in the cosmos. I want to know how a small human can impact such a tremendous universe. What realities and possibilities exist beyond the known world?

To understand the wonders of the cosmos, we need to first explore the beginning…the big bang. *A Short History of Nearly Everything* by Bill Bryson was written to explain the distant topics that exist in science and *How the Universe Works, Big Bang* is a TV series that explores individual topics. Through exploring these works, I realized how incredibly precise the universe must be to work. The Big Bang theory argues that there was once a hot dense mass that rapidly expanded and cooled to become the large intricate area that is the universe. Within a few minutes protons and neutrons were created, forming atomic nuclei. After thousands of years, these nuclei combined with electrons to make Hydrogen, Helium, and Lithium, the elements that make up stars and galaxies. One interesting point Bryson makes is how specific the events must have been to create a "Bang!", suggesting that there must have been thousands of "big bangs" before the one that began the age of the universe. We are in this new universe full of galaxies and stars, and when those stars engage in stellar nucleosynthesis[1], or explode and create a supernova is when things really get exciting. A star can create a supernova[2] by either colliding with a larger star (for instance, a white dwarf star and a red giant) or by simply decaying in nickel, the equivalent of dying of old age. The star's gravity pulls its outer layers inward and then explodes, creating elements from Iron to Uranium. These elements mean the birth of alkali metals, alkaline earth metals, and halogens. Now we have our basic periodic table, floating around in gravity and making up the universe we know today, but what exactly holds it all together? Dark matter.

Dark matter makes up about 83% of the universe, and it is what holds the galaxies in place. It does not emit or absorb light so scientists are still relatively unsure about what dark matter is made up of, but they do know it is what keeps the pieces of the Milky Way from flying in every direction. The reason why we know dark matter is out there is because stars and galaxies are arranged in clusters, and those clusters form superclusters, similar to the states organized in the United States. Clusters are comprised of 50-1,000 galaxies placed 500/600 miles apart, all held together in one big organized mass of dark matter. Our galaxy, the Milky Way, is not a part of a cluster, but a group. Groups are smaller than clusters, with around 50 galaxies[3]. The Milky Way is one of about 54 in a group called "The Local Group", first discovered by Edwin Hubble. The discoveries made about the cosmos is one way we have impacted this world, despite our relative size. The fact that scientists are able to pinpoint the beginning of the universe and the birth of elements is remarkable, and crucial to artificially producing elements in the case of supply shortages.

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[1] Nuclear reactions, taking place in stars to build the nucleus of elements heavier than Hydrogen- Wikipedia

[2] A stellar explosion caused by a star exploding- Wikipedia

[3] http://en.wikipedia.org/wiki/Galaxy_groups_and_clusters

In the early 1900's, Edwin Hubble suggested that there were galaxies other than the Milky Way[4]. In 1919, Hubble gazed at the cosmos through the Hooker telescope, the largest telescope yet, and was able to recognize foreign nebulae too far away to be considered part of the Milky Way galaxy. One galaxy he discovered was the Andromeda galaxy, which is about 2.5 million light years from the Milky Way, the nearest galaxy in time and closest in size. We don't know yet quite how many planets are in the Andromeda galaxy, but some say it could be millions, presenting all sorts of opportunities for other life-forms to be present. It is so humbling to think how much is out there. In 2004, in our own galaxy, the Mars Rover found water-tracks on planet Mars[5]. This was such an exciting discovery because water is the foundation to life. Another place there is thought to be life is on Europa, one of Jupiter's moons. Europa is covered by a thick wall of ice (estimated to be 15 miles deep) with a hot volcanic center. This combination of ice and heat can only suggest in between the two is a body of water, perhaps containing foreign species of amphibians.

These possibilities were discussed by Stephen Hawking during his show *Into the Universe*. With so much more out in the cosmos, it is really hard to believe that earth is the only planet sustaining life-forms. It is quite possible we are the sole provider to human intelligence, and that explains why no other beings have tried to contact us or even care that we exist. I think of the other planets as a rain forest. A rainforest can sustain itself from the inside, without any disturbances from other beings. The rainforest does not send out signals of life into the rest of the community nor does it need anything external for the organisms in its ecosystem to survive. The other planets that house possible life-forms are so far away that it would take lifetimes and billions of dollars to for us to reach them; and the life-forms could be so different than the common perception of an "alien" (ET...) that they have no urge or means to find and contact us.

SETI, the Search for Extraterrestrial Intelligence is a nonprofit leader in the quest for life outside earth. One of their most notable tools is the Allen Telescope Array (ATA), which surveys radio wavelengths, searching for a disruption possibly caused by an unknown being. They search for these wavelengths in two ways, one is by surveying the entire "microwave zone" (the area in which the satellites can pick up signal) and searching for a strong sign, and the other is by focusing on a star for a long period of time so that the satellites are more likely to pick up a weaker signal. Because SETI uses both of these techniques, they have quite a few small satellites in the ATA and hope to increase their number to 350 to achieve maximum monitoring in the microwave zone. By monitoring the whole zone, we can feel more connected to the vast unknown space as well as have higher chances of reaching other life-forms. By contacting other life-forms, we would be growing our community beyond planet earth, therefore unearthing many other possibilities for living.

Although scientists are making miraculous discoveries and learning more than we ever thought possible about the universe, there is one mass that will (seemingly) forever remain a mystery—black holes. What we know about black holes is that when a very large star (as big as 100 times our sun) explodes, gravity crushes the star and creates a hypernova[6]. The center of the star becomes a black hole and within a matter of seconds, eats the light and elements around it. The process of explosion is called a Gamma Ray Burst, and happens about once a day. Once the star is gone and the black hole is formed, the laws of physics break down and no one can be

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[4] http://www.edwinhubble.com/hubble_bio_001.htm

[5] Stephen Hawking, Into The Universe

[6] An immensely large star collapsing at the end of its lifespan.

exactly sure what happens from there. Imagine yourself floating along in space, taking in the bright stars and colorful planets. Eventually, you will approach the event horizon…the edge of a black hole, the edge of time and space. As you are sucked in with impossible force, time slows down for you and a process called spaghettification[7] occurs (all within seconds of real time). Spaghettification is exactly what it sounds like…the object (you) entering the black hole is stretched out like a piece of spaghetti. No one can know what happens from there; some people believe that black holes are the gateways to a parallel universe, but there is no way to be sure because once something is lost inside a black hole, it is gone from this universe forever. This concept reminds me of a *Star Trek* episode I once watched where the show suggested the universe as we know it could just be a decoration, like a snow globe on someone's desk. Of course, it is also highly likely that the black hole's force kills any living thing passing through, and literally destroys the energy of that previous form, but I think a parallel universe is a bit more exciting. A parallel universe adds another whole layer to our world, and just imagining what could be beyond is fun for the creative mind. Imagine all the fictional stories you've read—Dr. Seuss books, *Harry Potter*, *The Chronicles of Narnia*—what if those worlds exist beyond a black hole?

Knowing all that we do, and not knowing so much more, leaves me with two final questions. The first one: if we had endless resources to explore space, where should we go from here? I'm no scientist, but I would like to see families living in space, devoting their lives to the purpose of getting beyond a distance travelled in a lifetime. I know it is unrealistic to suggest that someone make the decision to abandon their lives and "donate" the rest of their lineage to space travel, but the remarkable discoveries we could make are beyond comprehension. Learning about such a vast topic can make a person feel meaningless. Learning about such a vast topic can also make one feel empowered, leading me to my second question: how can we still feel significant after acknowledging the gigantic size of the universe? At times I feel overwhelmed, as if all the technology and progress of human life is glorified because the earth is so small. The more I learn however, I feel excited and proud to be a member of this universe, no matter how small. By asking questions, pursuing change, engaging in trial and error, and learning as much as we can, I feel that the human race is doing their part for the universe. As Jill Tarter of SETI says, "We live on a fragile island of life in a universe of opportunity." I challenge you to seize each opportunity and master all that you can. You can never feel too big in this great world; however, we are all at risk of feeling too small.

[7] How The Universe Works: Black Holes